

CRITICAL ITEMS LIST (CIL)

No. 10-03-02-00/03

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Safety and Arming Device (1)
ASSEMBLY:	Safety and Arming Device 10-03-02	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-02-00 Rev M	PHASE(S):	Boost (BT)
CIL REV NO.:	M	QUANTITY:	(See Table A-3)
DATE:	31 Jul 2000	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	410-1ff.	HAZARD REF:	BI-03
DATED:	30 Jul 1999		
CIL ANALYST:	S. E. Rodgers		
APPROVED BY:		DATE:	
RELIABILITY ENGINEERING:	<u>K. G. Sanofsky</u>		<u>31 Jul 2000</u>
ENGINEERING:	<u>S. R. Graves</u>		<u>31 Jul 2000</u>

- 1.0 FAILURE CONDITION: Failure to operate (B)
- 2.0 FAILURE MODE: 1.0 Safety and Arming (S&A) Device "SAFED" when required to be "ARMED"
- 3.0 FAILURE EFFECTS: No ignition on one RSRM, causing thrust imbalance and loss of the RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Position indication switches indicate "ARM" when rotor is in "SAFE" position	
1.1.1	Electrical switch deck assembly or S&A device connector is reverse wired (i.e., indicates "ARMED" when "SAFED")	A
1.1.2	Barrier-Booster switch deck assembly improperly keyed to Barrier-Booster rotor shaft	B
1.1.3	Improper assembly	C
1.1.4	Contamination	D
1.2	Auto rotation of rotor from "ARM" position	
1.2.1	Failure of reduction gearing in arming-monitor	E
1.2.2	Weak or broken detent spring in Barrier-Booster	F
1.2.3	Dimensional mismatch between Barrier-Booster rotor and Pyrotechnic-Basket Assembly interfacing surfaces	G
1.2.4	Shock and vibration	H
1.2.5	Clutch failure	I

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5.0 REDUNDANCY SCREENS:

SCREEN A: N/A
SCREEN B: N/A
SCREEN C: N/A

6.0 ITEM DESCRIPTION:

1. Safety and Arming Device. Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U50266	Arming-Monitor Assembly S&A Device			1/Motor
1U50600	Actuator, A-M Assembly			1/Motor
1U50610	Gear Housing, Actuator	6061-T651	QQ-A-225/8	1/Motor
1U50612	Housing, Motor, Actuator Assembly	304 CRES	QQ-S-763	1/Motor
1U50622	Drive Support Actuator	Diallyl Phthalate	MIL-M-14 Type SGD	1/Motor
1U50623	Stop Plate, Switch Deck Assembly	6061-T6511	QQ-A-200/8	1/Motor
1U50627	Shaft, Drive, Actuator Assembly	416 CRES	ASTM-A-582	1/Motor
1U77755	Clutch Disk	Brake Block RF-34		1/Motor
1U50665	Gear Cluster, Spur	416 CRES	ASTM-A-581, A-582	3/Motor
		Copper, 642	QQ-C-465	
1U50667	Spring	Music wire	ASTM-A-228	1/Motor
1U50688	Rotor, Output Barrier	A286 CRES	AMS-5737	1/Motor
1U50695	Connector Assembly, Barrier-Booster (B-B)			1/Motor
1U51701	Basket, Booster	304 CRES	QQ-S-763 Cond A	1/Motor
1U51702	Basket Assembly, Booster			1/Motor
1U77100	Bearing, Corrosion Resistant	440C CRES		2/Motor
1U77383	Housing, Barrier-Booster	A286 CRES	AMS-5737	1/Motor
1U77385	Barrier-Booster Assembly S&A Device			1/Motor
1U77387	S/A Device, Rocket Motor			1/Motor

6.1 CHARACTERISTICS:

1. The RSRM Safe and Arm device meets established requirements for performance, design, development, test, manufacture, and acceptance for a two-part electromechanical Safety and Arming (S&A) device.
2. The Space Shuttle S&A device is designed to prevent inadvertent ignition of the SRB and to facilitate desired ignition on demand. It is a two part electromechanical assembly consisting of an Arming-Monitor Assembly and a Barrier-Booster Assembly.
3. The Arming-Monitor Assembly contains the electric drive motor, switches, reduction gears, clutch, manual safing mechanism, safing pin, and visual position indicator. The Barrier-Booster Assembly contains electrical position indicator circuits, a mechanical barrier, two initiators, and a Pyrotechnic-Basket Assembly. Figures 1, 2, and 3 show the S&A device, Barrier-Booster Assembly, switch and rotor shaft.

7.0 FAILURE HISTORY/RELATED EXPERIENCE:

1. Current data on test failures, flight failures, unexplained failures, and other failures during RSRM ground processing activity can be found in the PRACA Database.

8.0 OPERATIONAL USE: N/A

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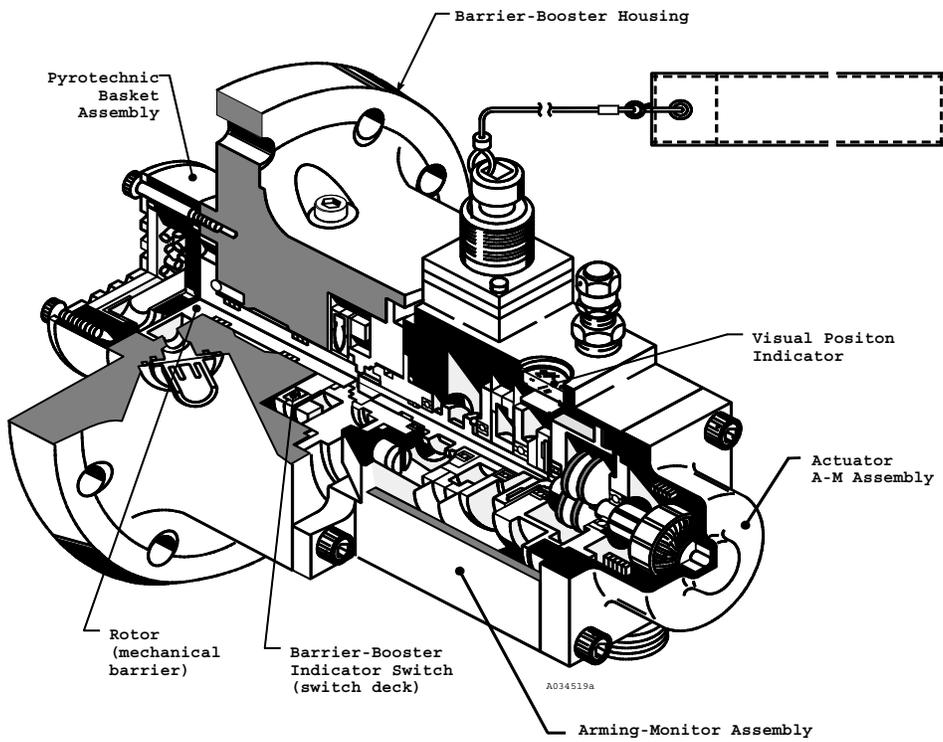


Figure 1. S&A Device

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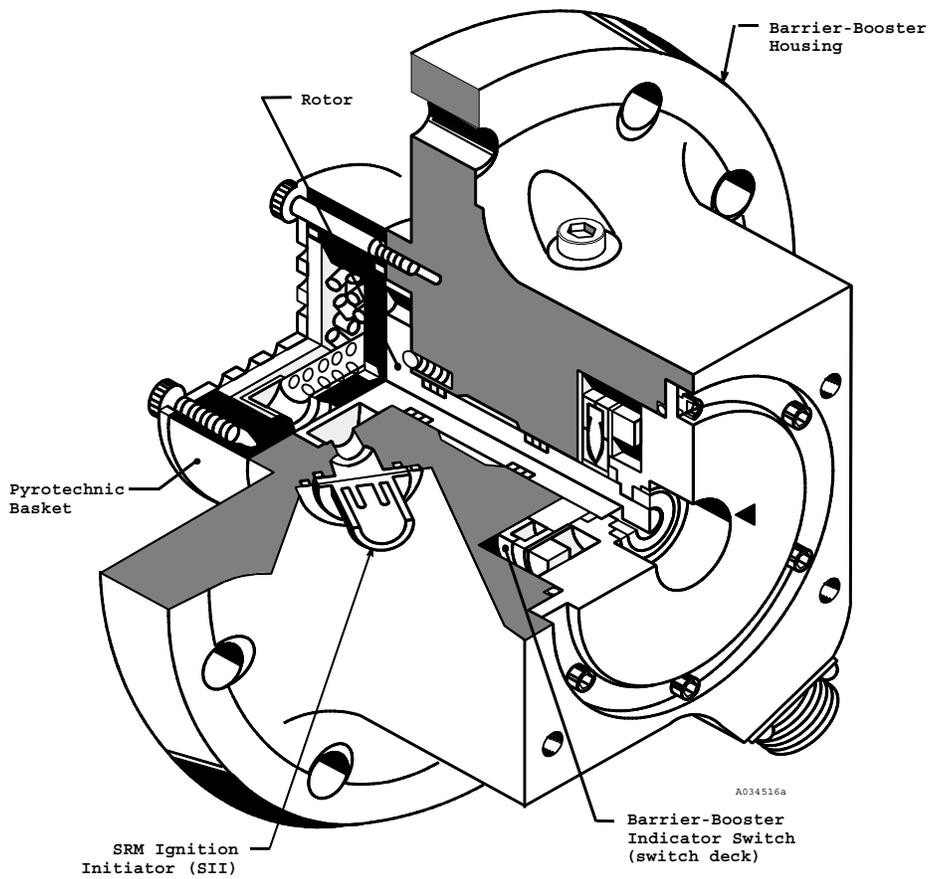


Figure 2. Barrier-Booster Assembly

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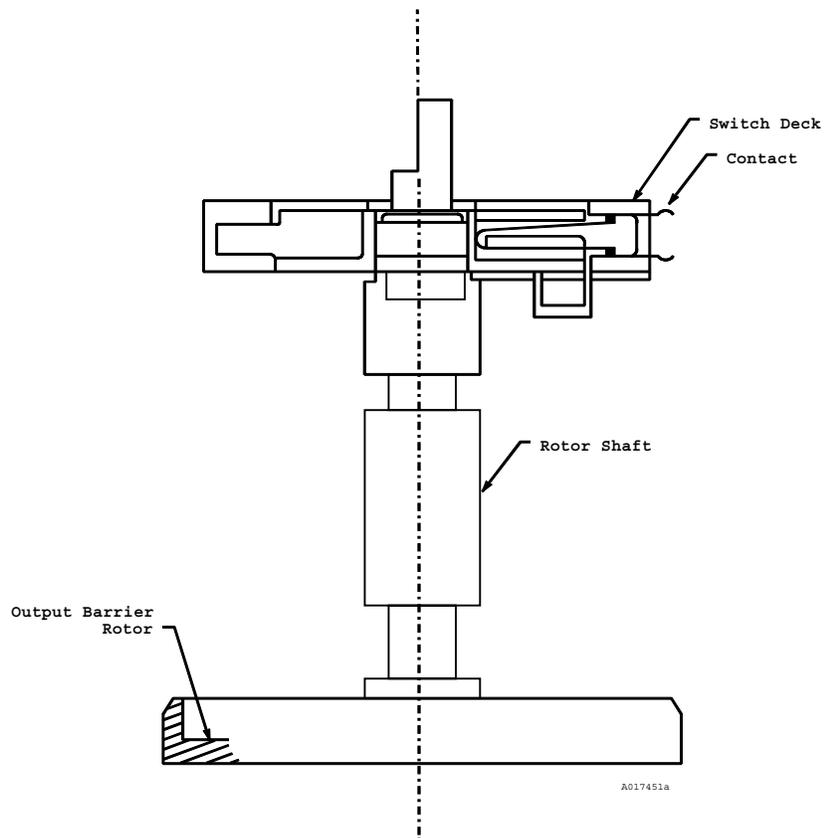


Figure 3. Switch Deck and Rotor Shaft

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9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

- | | | |
|-----------------------|-----|---|
| A,B,C,D,E,
F,G,H,I | 1. | The design is based on a similar successful design from the Short Range Attack Missile (SRAM) and Minuteman Programs per TWR-18157. |
| A,B,C,D | 2. | The three screw holes for attachment of the switch deck are arranged so that the switch deck may be installed in only one position per engineering drawings. |
| A,B,C,D | 3. | Wires are color-coded and length-controlled to preclude improper installation per engineering drawings. |
| A,B,C,D | 4. | The switch deck assembly is keyed to the Barrier-Booster Rotor in only one position. |
| A,B,C,D | 5. | The "SAFE" and "ARM" indicator circuits are independent per engineering drawings and TWR-18157. |
| A,B,C,D | 6. | The stop on the switch deck assembly prevents rotation of the rotor if the switch deck is installed incorrectly per engineering drawings. |
| A,B,C,D | 7. | Improper positioning of electrical contacts in the switch deck assembly prevents the full range of the rotor position indications from being obtained and would be detected during S&A device electrical checkout per engineering. |
| A,B,C,D | 8. | The switch deck assembly contacts are lubricated and the contacts are ultrasonically cleaned per engineering. The remaining detailed parts of the S&A device are cleaned per engineering. |
| A,B,C,D | 9. | The Arming Monitor Actuator Ball Bearings are CRES 440C steel per engineering drawings. Corrosion-resistant bearings are qualified for this application by similarity per TWR-50263. |
| E,F,G,H,I | 10. | The motor gearbox is located in the arming monitor actuator and provides rotational motion for safing and arming. The motor operates within a voltage range. The reduction gearbox has four gears within an aluminum housing and 625:1 gear reduction is used to multiply torque well above the required amounts. |
| E,F,G,H,I | 11. | Auto rotation of the S&A device rotor is prevented by a 625:1 gear reduction in the arming-monitor and by a ball and spring mechanical detent that positively retains the rotor in the "ARM" or the "SAFE" position. |
| E,F,G,H,I | 12. | The helical compression spring is formed from music wire conforming to ASTM A228, and cleaned and stress relieved per engineering drawings. |
| E,F,G,H,I | 13. | Dimensions for the pyrotechnic basket are controlled per engineering drawings. |
| E,F,G,H,I | 14. | Dimensions of the rotor are controlled per engineering drawings. |
| E,F,G,H,I | 15. | Alignment pin hole location and perpendicularity for the Booster Basket is per engineering drawings. |
| E,F,G,H,I | 16. | Eight S&A devices were designated as qualification test units and were subjected |

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to environmental exposure and functional tests equivalent to 25 flights of flight vibration, a 5000-cycle test, and a stalled arming test. All eight devices were still operable and did not incur a degree of wear or damage sufficient to preclude normal operation in an actual flight per TWR-12198.

- E,F,G,H,I 17. Shock and vibration levels to which the S&A device will be exposed during prelaunch are defined per engineering specifications and are lower than S&A design and qualification per TWR-18147.
- E,F,G,H,I 18. The actuator drive shaft is a passivated 416 Corrosion Resistant-Steel (CRES) turning. It has the clutch plate on the output end, a bearing surface, a square input spline, and a cylindrical shaft on which the number three gear cluster is mounted. The clutch plate is held perpendicular to the bearing surface and flat within specified values. The wear surface has a specified finish. The drive shaft turns in single-row radial ball bearings that are pressed into the gear housing. The bearing is CRES 440C steel per engineering drawings and TWR-50263. A shoulder on the drive shaft transfers the clutch axial load into the bearing and thus into the gear housing.
- E,F,G,H,I 19. The clutch disk rests between the drive faces of the function plate and clutch plates. It is supported radially by ball bearings mounted in bearing plates that are attached to the gear housing.
- E,F,G,H,I 20. The clutch assembly transmits the drive torque of the motor gearbox-to-the arming motor arming shaft. It allows the motor to overrun and limits the torque when the switch deck stops bottom.
- E,F,G,H,I 21. The pinion gear is heat treated CRES bar steel per Industry Specification ASTM A-581, Class 416. Dimensions are per engineering drawings.
- E,F,G,H,I 22. The spur gear is copper aluminum alloy No. 642 per Federal Specification, QQ-C-465. Dimensions are controlled per engineering drawings.

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9.2 TEST AND INSPECTION:

<u>DCN</u> <u>TESTS</u> (T)		<u>CIL CODES</u>
	1. For New S&A Device, verify:	
A,B,C,D,E, F,G,H,I (T)	a. Individual electrical checkout per specification	ADB011
A,B,C,D,E F,G,H,I	b. Certification review completed	DAA010
	2. For New Barrier-Booster Assembly verify:	
A,B,C,D,E, F,G,H,I (T)	a. Proper assembly per drawings and specifications	ACZ150
A,B,C,D	b. Electrical circuit testing	ACZ072
A,B,C,D	c. Correct installation of switch deck assembly	ACZ062
A,B,C,D,E, F,G,H,I	d. Certificate of Conformance	ACZ055
	3. For Refurbished Barrier-Booster Assembly, verify:	
A,B,C,D,E, F,G,H,I (T)	a. Proper assembly per drawings and specifications	ACZ150A
A,B,C,D	b. Electrical circuit testing	ACZ072A
A,B,C,D	c. Correct installation of switch deck assembly	ACZ062A
A,B,C,D,E, F,G,H,I	d. Certificate of Conformance	ACZ054A
	4. For New Barrier-Booster Housing, verify:	
E,F,G,H,I	a. True position of threaded holes in basket mounting boss	ACY155
E,F,G,H,I	b. Parallelism of basket mounting boss	ACY088
E,F,G,H,I	c. Alignment pin hole location	ACY001
E,F,G,H,I	d. Location of hole for detent device	ACY070
E,F,G,H,I	e. Depth of hole for detent device	ACY035
	5. For New Barrier-Booster Rotor, verify:	
E,F,G,H,I	a. Perpendicularity of rotor shaft to rotor flange	ACZ131
	6. For Refurbished Barrier-Booster Rotor, verify:	
E,F,G,H,I	a. Rotor inspected and refurbished	ABG048
	7. For New Booster Basket, verify:	
E,F,G,H,I	a. Run out of the alignment pin hole location	ACH000
E,F,G,H,I	b. Flatness of the Booster-Basket interface within tolerance	ACH010
E,F,G,H,I	c. Surface finish per view "B" of Booster Basket drawing	ACH016
E,F,G,H,I	d. True position of Booster-Basket threaded holes	ACH021
	8. For New Arming Monitor Assembly, verify:	
E,F,G,H,I	a. Vendor inspection sheets are and acceptable	AAX028

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| | 9. For New Arming Monitor Actuator, verify: | |
| E,F,G,H,I (T) | a. Minimum motor starting voltage | AAX023 |
| | 10. For Refurbished Barrier-Booster Connector Assembly, verify: | |
| A,B,C,D | a. Condition of refurbished switch deck and connector assembly | ABJ001 |
| | 11. KSC verifies: | |
| A,B,C,D (T) | a. S&A device for the following per OMRSD File V, Vol I, B000FL.006 | OMD022 |
| | 1. Proper packaging and storage of loaded Pyrotechnic Basket Assemblies and S&A devices | |
| | 2. Free from humidity or visible moisture | |
| | 3. Expended desiccant | |
| | 4. Bench test for "SAFE"- "ARM"- "SAFE" cycle | |
| | 5. Bench tests for arming cycle time, motor resistance, and insulation resistance | |
| A,B,C,D (T) | b. S&A device "SAFE"- "ARM"- "SAFE" verification test (prior to skirt closeout), KSC monitors the status of the "ARM" and "SAFE" position switches and visually verifies that the status is correct. If the wrong status is returned, KSC manually installs the safing pin and verifies that the S&A device is "SAFED" per OMRSD File V, Vol I, B47SA0.070 | OMD065 |
| A,B,C,D (T) | c. S&A device "SAFE"- "ARM"- "SAFE" verification test (prior to skirt closeout), KSC monitors the status of the "ARM" and "SAFE" position switches and visually verifies that the status is correct. If the wrong status is returned, KSC manually installs the safing pin and verifies that the S&A devices "SAFED" per OMRSD File V, Vol I B47SA0.080 | OMD066 |
| A,B,C,D,E, F,G,H,I (T) | d. Per the Launch Commit Criteria Document (NSTS 16007), S&A device is armed at approximately T-5 minutes and the status of both the "ARMED" and the "SAFED" position switches are continuously monitored from T-4:50 until RSRM ignition per OMRSD File II, Vol I, S00FM0.210 | OMD018 |